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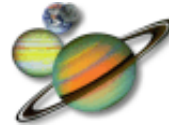
It is difficult to say what is impossible, for the dream of yesterday is the hope of today and the reality of tomorrow. - Robert Goddard

Universe Entered Iron Age 200 Million Years After Big Bang

By [rickyjames](#), Section [News](#)

Posted on Tue Sep 23rd, 2003 at 08:08:01 AM PST

From a [recent press release](#): Approximately 200 million years after the Big Bang, the universe underwent a dramatic burst of star formation. Those first stars were massive and fast-burning, quickly fusing their hydrogen fuel into heavier elements like carbon and oxygen. Nearing the end of their lives, desperate for energy, those stars burned carbon and oxygen to form heavier and heavier elements until reaching the end of the line with iron. Since iron cannot be fused to create energy, the first stars then **exploded** as supernovae, [blasting the elements that they had formed](#) into space.



"We were surprised by how violent the first supernova explosions were," says researcher Volker Bromm, whose research will be published in an upcoming Astrophysical Journal Letters. "A universe that was in a pristine state of tranquility was rapidly and irreversibly transformed by a colossal input of energy and heavy elements, setting the stage for the long cosmic evolution that eventually led to life and intelligent beings like us."

Those explosions spewed elements like carbon, oxygen and iron into the void at tremendous speeds. New simulations by astrophysicists Volker Bromm (Harvard-Smithsonian Center for Astrophysics), Naoki Yoshida (National Astronomical Observatory of Japan) and Lars Hernquist (CfA) show that the first, "greatest generation" of stars spread incredible amounts of such heavy elements across thousands of light-years of space, thereby seeding the cosmos with the stuff of life.

Each of those first giant stars converted about half of its mass into heavy elements, much of it iron. As a result, each supernova hurled up to 100 solar masses of iron into the interstellar medium. The death throes of each star added to the interstellar bounty. Hence, by the remarkably young age of 275 million years, the universe was substantially seeded with metals.

That seeding process was aided by the structure of the infant universe, where small protogalaxies less than one-millionth the mass of the Milky Way crammed together like people on a crowded subway car. The small sizes of and distances between those protogalaxies allowed an individual supernova to rapidly seed a significant volume of space.

Supercomputer simulations by Bromm, Yoshida, and Hernquist showed

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that the most energetic supernova explosions sent out shock waves that flung heavy elements up to 3,000 light-years away. Those shock waves swept huge amounts of gas into intergalactic space, leaving behind hot "bubbles," and triggered new rounds of star formation.

Supernova expert Robert Kirshner (CfA) says, "Today this is a fascinating theory, based on our best understanding of how the first stars worked. In a few years, when we build the [James Webb Space Telescope](#), the successor to the Hubble Space Telescope, we should be able to see these first supernovae and test Volker's ideas. Stay tuned!"

Lars Hernquist notes that the second generation of stars contained heavy elements from the first generation - seeds from which rocky planets like Earth could grow. "Without that first, 'greatest generation' of stars, our world would not exist."

Headquartered in Cambridge, Mass., the Harvard-Smithsonian Center for Astrophysics is a joint collaboration between the Smithsonian Astrophysical Observatory and the Harvard College Observatory. CFA scientists, organized into six research divisions, study the origin, evolution and ultimate fate of the universe.

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